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10/772,777	02/05/2004	Theodorus E. Standaert	2002 P 17753 US (BHGL No.	2367
48581	7590	10/17/2005	EXAMINER	
BRINKS HOFER GILSON & LIONE			NOVACEK, CHRISTY L	
INFINEON				
PO BOX 10395			ART UNIT	PAPER NUMBER
CHICAGO, IL 60610			2822	

DATE MAILED: 10/17/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

10/772,777

Applicant(s)

STANDAERT ET AL.

Examiner

Christy L. Novacek

Art Unit

2822

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 08 August 2005.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1 and 3-25 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1 and 3-25 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on \_\_\_\_\_ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
  - ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

## Attachment(s)

- ☒ Notice of References Cited (PTO-892)
- ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date 5/9/05.
- ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- ☐ Notice of Informal Patent Application (PTO-152)
- ☐ Other: \_\_\_\_\_.

### **DETAILED ACTION**

This office action is in response to the amendment filed August 8, 2005.

#### ***Response to Amendment***

The amendment of claims 16, 21, 23 and 25 is sufficient to overcome the objections to claims 16, 21, 23 and 25 stated in the previous office action. Therefore, these objections are withdrawn.

The limitations added to claims 1, 17, 22 and 24 are sufficient to overcome the You et al. (US 6,663,787) and Layadi et al. (US 6,180,518) references.

#### ***Specification***

The specification is objected to as failing to provide proper antecedent basis for the claimed subject matter. See 37 CFR 1.75(d)(1) and MPEP § 608.01(o). Correction of the following is required: Claims 14 and 19 recite the limitation of “a dielectric hardmask”. The specification does not disclose forming a hardmask made of a dielectric material.

#### ***Claim Objections***

Claim 17 is objected to because of the following informalities: In line 7 of claim 17, “metal-lined~~u~~” should be replaced with “metal-liner~~u~~” or “metal-lined feature”. Appropriate correction is required.

#### ***Claim Rejections - 35 USC § 112***

The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it

Art Unit: 2822

pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 14, 15, 19 and 20 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The amendment filed on August 8, 2005 adds limitations into claims 14 and 19 that are not supported by the original specification and claims. The specification, as originally filed, does not disclose forming a hardmask made of a dielectric material. The specification and claims, as originally filed do not provide support for the amended claim limitations of transferring a pattern of a metal hardmask to a dielectric hardmask.

### *Claim Rejections - 35 USC § 102*

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 16, 21, 23 and 25 are rejected under 35 U.S.C. 102(e) as being anticipated by You et al. (US 6,663,787, previously cited).

Regarding claim 16, You discloses providing a dielectric portion (112/114/113), etching the dielectric portion to produce a feature, during said etching step providing on the feature a liner material (119) to produce a lined feature, and depositing a conductive material (122) on the lined feature (Fig. 4D-4G; col. 13, ln. 25 – col. 16, ln. 26). You does not disclose using reactive ion etching. However, this limitation is a method step, while the claim is a product claim.

“[E]ven though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does

Art Unit: 2822

not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process.” *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

Regarding claim 21, You discloses providing a dielectric portion (112/114/113), in an etch chamber, etching the dielectric portion to produce a feature, in the etch chamber, providing on the feature a liner material (119) to produce a lined feature, and depositing a conductive material (122) on the lined feature (Fig. 4D-4G; col. 13, ln. 25 – col. 16, ln. 26). You does not disclose using reactive ion etching. However, this limitation is a method step, while the claim is a product claim. “[E]ven though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process.” *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985):

Regarding claim 23, You discloses providing a low-k dielectric portion, etching the low-k dielectric portion to produce a feature, during the etching step providing a metallic liner on the feature to produce a lined feature, and depositing copper on the lined feature. You does not disclose using reactive ion etching. However, this limitation is a method step, while the claim is a product claim. “[E]ven though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process

Art Unit: 2822

claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process.” *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

Regarding claim 25, You discloses providing a low-k dielectric portion, in an etch chamber, etching the low-k dielectric portion to produce a feature, in the etch chamber, providing a metallic liner on the feature to produce a lined feature, and depositing copper on the lined feature. You does not disclose using reactive ion etching. However, this limitation is a method step, while the claim is a product claim. “[E]ven though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process.” *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

Claims 16, 21, 23 and 25 are rejected under 35 U.S.C. 102(e) as being anticipated by You et al. (US 6,689,684).

Regarding claims 16 and 21, You discloses a dielectric portion having a feature with sidewalls and a bottom etched thereon, a metallic liner lining the two sidewalls and a bottom of the feature and a conductive material deposited on the lined feature. You does not disclose using reactive ion etching. However, this limitation is a method step, while the claim is a product claim. “[E]ven though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the

Art Unit: 2822

same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process.” *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

Regarding claim 23, You discloses a low-k dielectric portion having a feature with sidewalls and a bottom, a metallic liner on the sidewalls and the bottom of the feature and copper deposited on the lined feature. You does not disclose using reactive ion etching. However, this limitation is a method step, while the claim is a product claim. “[E]ven though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process.” *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

Regarding claim 25, You discloses a low-k dielectric portion having a feature with sidewalls and a bottom, a metallic liner on the sidewalls and the bottom of the feature and copper deposited on the lined feature. You does not disclose using reactive ion etching. However, this limitation is a method step, while the claim is a product claim. “[E]ven though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process.” *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

The text of those sections of Title 35, U.S. Code not included in this action can be found in a prior Office action.

Claims 1, 3-12, 14, 17-19, 22 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over You et al. (US 6,689,684) in view of Wolf et al. ("Silicon Processing for the VLSI Era") and Tang (US 6,143,649).

Regarding claim 1, You discloses providing a dielectric portion (84/86), etching the dielectric portion to produce a feature having sidewalls and a bottom, during said etching step providing a metallic liner material (83A/110) on the sidewalls and bottom of the feature to produce a metal-lined feature, and depositing a conductive material (122B) on the lined feature (Fig. 10-12; col. 6, ln. 33 – col. 7, ln. 17). You discloses that the dielectric portion is etched anisotropically but does not disclose any particular etching method. You discloses that the metallic liner is formed by sputtering. Wolf discloses that RIE is an anisotropic etching process that is beneficial to use because it provides more selectivity than a sputtering process (pg. 541-542). Wolf discloses that the RIE etching takes place within an etch chamber (pg. 568-569). Like You, Tang discloses a process of forming a via and etching/redepositing a portion of a hard mask layer of TaN to form a redeposited TaN barrier layer on the sidewalls of the via (col. 6, ln. 44 – col. 7, ln. 43). Tang teaches that the TaN hardmask can be successfully etched and redeposited using RIE. At the time of the invention, it would have been obvious to one of ordinary skill in the art to use RIE to etch the dielectric portion and hardmask of You because Wolf teaches that it is beneficial to use RIE to etch layers because the RIE etch is more selective than a sputtering etch and Tang teaches that RIE can be used to successfully etch and redeposit a hardmask of TaN on the walls of a via.



Regarding claims 3 and 18, You discloses that the liner providing step includes redepositing sputter products from a metal hardmask. For the reasons discussed above in relation to claim 1 and below in relation to claim 17, it would have been obvious to one of ordinary skill in the art to use RIE to etch the hardmask.

Regarding claims 4 and 7, Wolf discloses that RIE involves using a halocarbon gas such as a fluorocarbon gas (pg. 541-543).

Regarding claim 5, Wolf discloses that a fluorocarbon gas such as  $\text{CF}_4$  can be used to do the reactive ion etching (pg. 543).

Regarding claim 6, You discloses that the hardmask can be TaN (col. 6, ln. 35-40).

Regarding claims 8 and 9, You discloses that the dielectric portion can include a low-k organic dielectric (col. 5, ln. 13-34).

Regarding claim 10, You discloses forming a seed layer (121) on the liner material before the step of depositing the conductive material (col. 7, ln. 7-10).

Regarding claim 11, You discloses that the conductive material is copper (col. 7, ln. 1-16).

Regarding claim 12, You discloses that the feature is a via.

Regarding claims 14 and 19, Wolf and Tang both disclose various ranges of pressures, RF power and gaseous flow rates and how to adjust them according to the specific etching need (pg. 543-551 of Wolf and col. 7, ln. 25-43 of Tang). Therefore, at the time of the invention, it would have been obvious to one of ordinary skill in the art to use routine experimentation to determine optimum pressure, RF power and flow rate ranges for the etching disclosed by You because Wolf and Tang disclose general ranges of these variables and because such variables of

Art Unit: 2822

art recognized importance are subject to routine experimentation and discovery of an optimum value for such variables is obvious. See *In re Aller*, 105 USPQ 233 (CCPA 1955).

Regarding claim 17, You discloses providing a dielectric portion (84/86), etching the dielectric portion to produce a feature having sidewalls and a bottom, during said etching step providing a metallic liner material (83A/110) on the sidewalls and bottom of the feature to produce a metal-lined feature, and depositing a conductive material (122B) on the lined feature (Fig. 10-12; col. 6, ln. 33 – col. 7, ln. 17). You discloses that the dielectric portion is etched anisotropically but does not disclose any particular etching method. You discloses that the metallic liner is formed by sputtering. Wolf discloses that RIE is an anisotropic etching process that is beneficial to use because it provides more selectivity than a sputtering process (pg. 541-542). Wolf discloses that the RIE etching takes place within an etch chamber (pg. 568-569). Like You, Tang discloses a process of forming a via and etching/redepositing a portion of a hard mask layer of TaN to form a redeposited TaN barrier layer on the sidewalls of the via (col. 6, ln. 44 – col. 7, ln. 43). Tang teaches that the TaN hardmask can be successfully etched and redeposited using RIE. At the time of the invention, it would have been obvious to one of ordinary skill in the art to use RIE to etch the dielectric portion and hardmask of You because Wolf teaches that it is beneficial to use RIE to etch layers because the RIE etch is more selective than a sputtering etch and Tang teaches that RIE can be used to successfully etch and redeposit a hardmask of TaN on the walls of a via.

Regarding claim 22, You discloses providing a low-k dielectric portion (84/86), etching the dielectric portion to produce a feature having sidewalls and a bottom, during said etching step providing a metallic liner material (83A/110) on the sidewalls and bottom of the feature to

Art Unit: 2822

produce a metal-lined feature, and depositing copper (122B) on the lined feature (Fig 10-12; col. 6, ln. 33 – col. 7, ln. 17). You discloses that the dielectric portion is etched anisotropically but does not disclose any particular etching method. You discloses that the metallic liner is formed by sputtering. Wolf discloses that RIE is an anisotropic etching process that is beneficial to use because it provides more selectivity than a sputtering process (pg. 541-542). Wolf discloses that the RIE etching takes place within an etch chamber (pg. 568-569). Like You, Tang discloses a process of forming a via and etching/redepositing a portion of a hard mask layer of TaN to form a redeposited TaN barrier layer on the sidewalls of the via (col. 6, ln. 44 – col. 7, ln. 43). Tang teaches that the TaN hardmask can be successfully etched and redeposited using RIE. At the time of the invention, it would have been obvious to one of ordinary skill in the art to use RIE to etch the dielectric portion and hardmask of You because Wolf teaches that it is beneficial to use RIE to etch layers because the RIE etch is more selective than a sputtering etch and Tang teaches that RIE can be used to successfully etch and redeposit a hardmask of TaN on the walls of a via.

Regarding claim 24, You discloses providing a low-k dielectric portion (84/86), etching the dielectric portion to produce a feature having sidewalls and a bottom, during said etching step providing a metallic liner material (83A/110) on the sidewalls and bottom of the feature to produce a metal-lined feature, and depositing copper (122B) on the lined feature (Fig 10-12; col. 6, ln. 33 – col. 7, ln. 17). You discloses that the dielectric portion is etched anisotropically but does not disclose any particular etching method. You discloses that the metallic liner is formed by sputtering. Wolf discloses that RIE is an anisotropic etching process that is beneficial to use because it provides more selectivity than a sputtering process (pg. 541-542). Wolf discloses that the RIE etching takes place within an etch chamber (pg. 568-569). Like You, Tang discloses a

Art Unit: 2822

process of forming a via and etching/redepositing a portion of a hard mask layer of TaN to form a redeposited TaN barrier layer on the sidewalls of the via (col. 6, ln. 44 – col. 7, ln. 43). Tang teaches that the TaN hardmask can be successfully etched and redeposited using RIE. At the time of the invention, it would have been obvious to one of ordinary skill in the art to use RIE to etch the dielectric portion and hardmask of You because Wolf teaches that it is beneficial to use RIE to etch layers because the RIE etch is more selective than a sputtering etch and Tang teaches that RIE can be used to successfully etch and redeposit a hardmask of TaN on the walls of a via.

Claim 13 is rejected under 35 U.S.C. 103(a) as being unpatentable over You et al. (US 6,689,684) in view of Wolf et al. (“Silicon Processing for the VLSI Era”) and Tang (US 6,143,649), as applied to claim 1 above, and further in view of Lin et al. (US 6,743,732, previously cited).

Regarding claim 13, You does not disclose using reactive ion etching (RIE). Lin discloses that a TEL SCCM etch tool can successfully be used to etch a dielectric portion (col. 3, ln. 40-46). At the time of the invention, it would have been obvious to one of ordinary skill in the art to use the TEL SCCM apparatus of Lin to conduct the RIE of You because Lin teaches that this apparatus can successfully be used to reactive ion etch a dielectric portion.

Claims 15 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over You et al. (US 6,689,684) in view of Wolf et al. (“Silicon Processing for the VLSI Era”) and Tang (US 6,143,649), as applied to claims 1 and 17 above, and further in view of Layadi et al. (US 6,180,518, previously cited).

Regarding claims 15 and 20, You does not disclose how the organic dielectric portion is etched. Layadi discloses reactive ion etching an organic portion of the dielectric portion using an etch gas that is a mixture of N<sub>2</sub> and H<sub>2</sub>, but does not disclose the etch parameters (col. 4, ln. 25-26). At the time of the invention, it would have been obvious to one of ordinary skill in the art to use the etching method of Layadi because Layadi teaches that this method can successfully etch an organic dielectric and it would be obvious to use routine experimentation to determine appropriate parameters for the etching of the organic dielectric because such variables of art recognized importance are subject to routine experimentation and discovery of an optimum value for such variables is obvious. See *In re Aller*, 105 USPQ 233 (CCPA 1955).

### ***Response to Arguments***

Applicant's arguments filed August 8, 2005 have been fully considered but they are not persuasive.

Regarding the rejection of claims 16, 21, 23 and 25 as being anticipated by You et al. (US 6,663,787), Applicant argues that You does not disclose a metallic liner lining two sidewalls and a bottom of the feature. Figure 4F of You shows that a metallic liner formed of redeposited tantalum nitride (119) and adhesion/barrier tantalum nitride layer (120) lines the sidewalls and bottom of the feature. Furthermore, because claims 16, 21, 23 and 25 are product-by-process claims, the limitations of etching the dielectric with reactive ion etching and the liner being produced by the etching are not considered because "[E]ven though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the

Art Unit: 2822

claim is unpatentable even though the prior product was made by a different process.” *In re Thorpe*, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985). The via of You meets all of the limitations of the structure of the product recited in claims 16, 21, 23 and 25.

The other arguments in Applicant’s response are moot in view of the new grounds of rejection.

### ***Conclusion***

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Christy L. Novacek whose telephone number is (571) 272-1839. The examiner can normally be reached on Monday-Thursday and alternate Fridays 7:30 - 5:00.

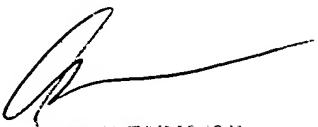
Art Unit: 2822

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (571) 272-1852. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

CLN

October 13, 2005



AMIR ZARABIAN  
SUPERVISORY PATENT EXAMINER  
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